Af/2822

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re application of

MANABU TOMITA

Serial No. 09/387,477 (TI-26105)

Filed September 1,1999

For: SEMICONDUCTOR DEVICE AND MANUFACTURING METHOD THEREOF

Art Unit 2822

Examiner M. Guerrero

Director of the United States
Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

SECOND SUBSTITUTE BRIEF ON APPEAL

REAL PARTY IN INTEREST

The real party in interest is Texas Instruments Incorporated, a Delaware corporation with offices at 7839 Churchill Way, Dallas, Texas 75251.

RELATED APPEALS AND INTERFERENCES

There are no known related appeals and/or interferences.

STATUS OF CLAIMS

This is an appeal of claims 1 and 3 to 7, all of the rejected claims. No claims have been allowed. Please charge any costs to Deposit Account No. 20-0668.

STATUS OF AMENDMENTS

An amendment filed after final rejection was not entered and a Petition is now pending requesting entry of the amendment filed after final rejection..

SUMMARY OF INVENTION

The invention relates to etching chemistry used in a semiconductor device manufacturing method. There is provided a semiconductor substrate having a lower electrically conducting layer (2 which includes 4, 5, 6 and 7) thereon and an electrically insulating layer disposed over the electrically conducting layer (3 which includes 10, 9 and 8). A gas etchant is provided having a mixed gas of two different fluorocarbon gases, one of the fluorocarbon gases having a low carbon atoms to fluorine atoms ratio (hereinafter C/F ratio) and the other gas having a high C/F ratio, with the fluorocarbon gas having the lower ratio of carbon atoms to fluorine atoms forming at least one half of the mixed gas. A connection hole (11) is etched through the electrically insulating layer (3) in a single etching step to the electrically conducting layer using only the mixed gas as the etchant. C_4F_8 is preferably used as the fluorocarbon gas having a lower ratio of carbon atoms to fluorine atoms and one of CHF_3, CH_2F_2, and CF_4 is used as the fluorocarbon gas having a higher ratio of carbon atoms to fluorine atoms. The insulating layer is preferably plasma-etched with the mixed gas of fluorocarbon gases. An upper electrically conducting layer can be connected to the lower electrically conducting layer formed in the connection hole as an electrode or wiring which can have a titanium nitride layer on the surface where the connection hole is formed and the electrically insulating layer can include a spin-on glass layer. Alternatively, the lower electrically conducting layer can be made of a stacked structure having a titanium nitride layer, a layer of aluminum or an alloy thereof, a titanium layer, and a titanium nitride layer stacked in that order, and the electrically insulating layer can

be made of a stacked structure having a silicon oxide layer formed from tetraethylorthosilicate, a spin-on glass layer, and a silicon oxide layer formed from tetraethylorthosilicate stacked in that order.

ISSUES

The issues on appeal are as follows:

1. Whether claims 1 and 3 to 7 comply with the requirements of 35 U.S.C. 112, first paragraph in that they contain subject matter which was described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

2. Whether claims 1, 3 and 4 are anticipated by Arleo et al. (U.S. 5,176,790) under 35 U.S.C. 102(b).

3. Whether claims 1 and 3 are anticipated by Liu et al. (U.S. 5,906,948) under 35 U.S.C. 102(e).

4. Whether claim 1 is anticipated by Tang et al. (U.S. 6,211,092) under 35 U.S.C. 102(e),

5. Whether claims 3 to 7 are unpatentable over Tang et al. in view of Miyazaki et al. (U.S. 5,804,878) under 35 U.S.C. 102(a).

GROUPING OF CLAIMS

The claims do not stand or fall together for reasons set forth hereinbelow under ARGUMENT.

ARGUMENT

ISSUE 1

Claims 1 and 3 to 7 were rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. It is stated that the specification does not provide support for the new limitation "the fluorocarbon gas having the lower ratio of carbon atoms to fluorine atoms forming at least one half of the mixed gas". The rejection is without merit.

The subject matter allegedly not described in the specification is found in claim 2 as originally filed which recites that the mixed gases of claim 1 "where equal amounts or less of a second fluorocarbon gas with a small C/F ratio to a first fluorocarbon gas with a large C/F ratio are mixed". To avoid this issue, the subject matter of originally filed claims 1 and 2 was requested to be added to the specification in the amendment filed after final rejection. A petition is presently pending on the entry of that amendment, however, as above demonstrated, the rejection is without merit in any event since the subject matter in question is contained in the application as originally filed..

ISSUE 2

Claims 1, 3 and 4 were rejected under 35 U.S.C. 102(b) as being anticipated by Arleo et al. (U.S. 5,176,790). The rejection is again respectfully without merit.

Claim 1 requires, among other steps, the step of providing a gas etchant comprising a mixed gas of two different fluorocarbon gases, one of the fluorocarbon gases having a low C/F

ratio and the other of said gases having a high C/F ratio, the fluorocarbon gas having the lower ratio of carbon atoms to fluorine atoms forming at least one half of the mixed gas. No such step is taught or even remotely suggested by Arleo et al. taken alone or in the total combination as claimed.

Claim 1 further requires the step of etching a connection hole through the electrically insulating layer in a single etching step to the electrically conducting layer using only the mixed gas as the etchant. No such step is taught or even remotely suggested by Arleo et al. taken alone or in the total combination as claimed.

Claims 3 and 4 depend from claim 1 and therefore define patentably over Arleo for at least the reasons presented above with reference to claim 1.

In addition, claim 3 further limits claim 1 by requiring that C_4F_8 be used as the fluorocarbon gas having a lower ratio of carbon atoms to fluorine atoms and at least one selected from the group composed of CHF_3, CH_2F_2, and CF_4 be used as the fluorocarbon gas having a higher ratio of carbon atoms to fluorine atoms. No such step is taught or even remotely suggested by Arleo et al. in the total combination as claimed.

Claim 4 further limits claim 1 by requiring that the insulating layer be plasma-etched with the mixed gas of fluorocarbon gases. No such step is taught or even remotely suggested by Arleo in the total combination as claimed.

ISSUE 3

Claims 1 and 3 were rejected under 35 U.S.C. 102(e) as being anticipated by Liu et al. (U.S. 5,906,984). The rejection is without merit.

The same argument as applied above as to claim 1 applies herein. The fact that column 3, lines 20 to 29 have an overlap in the amounts of small C/F ratio to high C/F ratio is not a

teaching to use the fluorocarbon gas having the lower C/F ratio in an amount at least one half of the mixed gas. While this step can be extracted with hindsight from Liu et al. by combining selected portions of the gases recited, it is clear that Liu et al. never appreciated the fact that a combination of gases as claimed in claim 1 could, alone, perform the task required and provide the benefits as set forth in the subject specification. This fact is made eminently clear from the fact that Liu et al. requires two separate etching steps at different flow rates to complete the etching step. It follows that, in view of the above described step of claim 1, Liu et al. fails to provide the step of etching a connection hole through the electrically insulating layer in a single etching step to the electrically conducting layer using only the mixed gas as the etchant. No such step is taught or even remotely suggested by Liu et al. taken alone or in the total combination as claimed.

Claim 3 depends from claim 1 and therefore defines patentably over Liu et al for at least the reasons presented above with reference to claim 1.

In addition, claim 3 further limits claim 1 by requiring that C_4F_8 be used as the fluorocarbon gas having a lower ratio of carbon atoms to fluorine atoms and at least one selected from the group composed of CHF_3, CH_2F_2, and CF_4 be used as the fluorocarbon gas having a higher ratio of carbon atoms to fluorine atoms. No such step is taught or even remotely suggested by Liu et al in the total combination as claimed.

ISSUE 4

Claim 1 was rejected under 35 U.S.C. 102(e) as being anticipated by Tang et al. (U.S. 6,211,092). The rejection is without merit.

The argument presented above with reference to claim 1 in the rejection under Arleo et al. applies as well to this rejection.

ISSUE 5

Claims 2 to 7 were rejected under 35 U.S.C. 103(a) as being unpatentable over Tang in view of Miyazaki et al. (U.S. 5, 804,878). The rejection is without merit.

Claims 3 to 7 depend from claim 1 and therefore define patentably over Tang in view of Miyazaki et al. since Miyazaki et al. fails to overcome the deficiencies in Tang as set forth above.

In addition, claim 3 further limits claim 1 by requiring that C_4F_8 be used as the fluorocarbon gas having a lower ratio of carbon atoms to fluorine atoms and at least one selected from the group composed of CHF_3, CH_2F_2, and CF_4 be used as the fluorocarbon gas having a higher ratio of carbon atoms to fluorine atoms. No such step is taught or even remotely suggested by Tang, Miyazaki et al. or any proper combination of these references in the total combination as claimed.

Claim 4 further limits claim 1 by requiring that the insulating layer be plasma-etched with the mixed gas of fluorocarbon gases. No such step is taught or even remotely suggested by Tang, Miyazaki et al. or any proper combination of these references in the total combination as claimed.

Claim 5 further limits claim 1 by requiring an upper electrically conducting layer connected to the lower electrically conducting layer formed in the connection hole as an electrode or wiring. No such step is taught or even remotely suggested by Tang, Miyazaki et al. or any proper combination of these references in the total combination as claimed.

Claim 6 further limits claim 5 by requiring that the lower electrically conducting layer have a titanium nitride layer on the surface where the connection hole is formed and the electrically insulating layer include a spin-on glass layer. No such step is taught or even

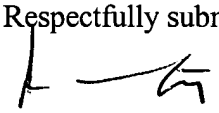
remotely suggested by Tang, Miyazaki et al. or any proper combination of these references in the total combination as claimed.

Claim 7 further limits claim 6 by requiring that the lower electrically conducting layer be made of a stacked structure having a titanium nitride layer, a layer of aluminum or an alloy thereof, a titanium layer, and a titanium nitride layer stacked in that order, and the electrically insulating be made of a stacked structure having a silicon oxide layer formed from tetraethylorthosilicate, a spin-on glass layer, and a silicon oxide layer formed from tetraethylorthosilicate stacked in that order. No such step is taught or even remotely suggested by Tang, Miyazaki et al. or any proper combination of these references in the total combination as claimed.

CONCLUSIONS

For the reasons stated above, reversal of the final rejection and allowance of the claims on appeal is requested that justice be done in the premises.

Respectfully submitted,



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APPENDIX

The claims on appeal read as follows:

1. A semiconductor device manufacturing method comprising the steps of:

providing a semiconductor substrate having a lower electrically conducting layer thereon and an electrically insulating layer disposed over said electrically conducting layer;

providing a gas etchant comprising a mixed gas of multiple different fluorocarbon gases, each fluorocarbon gas having a different ratio of carbon atoms to fluorine atoms, the fluorocarbon gas having the lower ratio of carbon atoms to fluorine atoms forming at least one half of the mixed gas; and

etching a connection hole through said electrically insulating layer in a single etching step to said electrically conducting layer using only said mixed gas as the etchant.

3. A semiconductor device manufacturing method as described in Claim 1 wherein C_4F_8 is used as the fluorocarbon gas having a lower ratio of carbon atoms to fluorine atoms and at least one selected from the group composed of CHF_3, CH_2F_2, and CF_4 is used as the fluorocarbon gas having a higher ratio of carbon atoms to fluorine atoms.

4. A semiconductor device manufacturing method described in Claim 1 wherein the insulating layer is plasma-etched with the mixed gas of fluorocarbon gases.

5. A semiconductor device manufacturing method [device] described in Claim 1 a lower conducting layer is formed on the semiconductor substrate as an electrode or wiring, a

connection hole is formed by etching the insulating layer that covers the lower conducting layer, and] further including an upper electrically conducting layer connected to the lower electrically conducting layer formed in the connection hole as an electrode or wiring.

6. A semiconductor device manufacturing method described in Claim 5 wherein the lower electrically conducting layer has a titanium nitride layer on the surface where the connection hole is formed and the electrically insulating layer includes a spin-on glass layer.

7. A semiconductor device manufacturing method described in Claim 6 wherein the lower electrically conducting layer is made of a stacked structure having a titanium nitride layer, a layer of aluminum or an alloy thereof, a titanium layer, and a titanium nitride layer stacked in that order, and the electrically insulating is made of a stacked structure having a silicon oxide layer formed from tetraethylorthosilicate, a spin-on glass layer, and a silicon oxide layer formed from tetraethylorthosilicate stacked in that order.